81-10026
CR-163502

SECOND QUARTERLY REPORT

FOR

EQUIVALENT SOURCE MODELING OF THE MAIN FIELD USING MAGSAT DATA

(E81-10026) EQUIVALENT SOURCE MODELING OF THE MAIN FIELD USING MAGSAT DATA Quarterly Report, 1 Apr. - 30 Jun. 1980 (Business and Technological Systems, Inc.) 4 p HC A02/MF A01 CSCL 08F G3/43 N81-12503 Unclas 00026

Contract NAS 5-26047

For the period

April 1, 1980 - June 30, 1980

submitted to

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
Greenbelt, Maryland 20771

by

BUSINESS AND TECHNOLOGICAL SYSTEMS, INC.
Aerospace Building, Suite 440
10210 Greenbelt Road
Seabrook, Maryland 20801

During this quarterly period the following work has been done on software development for equivalent dipole source modeling of the main magnetic field.

(1) A detailed spatial statistical output capability has been implemented into the program. For each data type, B , B_r , B_θ , B_ϕ , a distribution of the data residuals is presented in increments of 10γ , and the spatial distributions of the RMS, MEAN and data is plotted on a global 10°×10° grid.

(2) A subroutine SPHCØE has been developed to compute the equivalent spherical harmonic representation from the dipole distribution. Let

$$V(r,\theta,\lambda) = \bar{a}\left[\sum_{n=1}^{N}\left(\frac{\bar{a}}{r}\right)^{n+1}\sum_{m=0}^{n}(g_{nm}\cos m\lambda+h_{nm}\sin m\lambda)\,P_{nm}(\cos\theta)\right.$$

$$\left.+\left(\frac{r}{\bar{a}}\right)(\bar{g}_{10}P_{10}(\cos\theta)+(\bar{g}_{11}\cos\lambda+\bar{h}_{11}\sin\lambda)\,P_{11}(\cos\theta))\right]$$

be the scalar potential of the main field where the Legendre polynomials are Schmidt normalized. The last term represents that portion of the potential originating from sources outside of the sphere of radius $\bar{a}$ (three parameter external field model). The magnetic field is then

$$\bar{B} = -\nabla V \ .$$

Consider the set of $\{j\}$ dipoles, where the i^{th} dipole is described by a magnetization vector

$$M_{r_i} \ , M_{\theta_i} \ , M_{\lambda_i}$$

and a spatial portion

$$r_i \ , \theta_i \ , \lambda_i \ .$$

The spherical harmonic coefficients are then given by (in Schmidt normalized form)

$$g_{nm}=(\bar{a})^{-(n+2)}\sum_{i=1}^{\{j\}} r_i^{n-1}\left[n\, M_{r_i}\, P_{nm}(\cos\theta_i)\cos m\lambda_i\right.$$

$$\left.+ M_{\theta_i}\frac{\partial P_{nm}(\cos\theta_i)}{\partial\theta}\cos m\,\lambda_i - m\, M_{\lambda_i}\, P_{nm}(\cos\theta_i)\frac{\sin m\lambda_i}{\sin\theta_i}\right]$$

$$h_{nm}=(\bar{a})^{-(n+2)}\sum_{i=1}^{\{j\}} r_i^{n-1}\left[n\, M_{r_i}\, P_{nm}(\cos\theta_i)\sin m\lambda_i\right.$$

$$\left.+ M_{\theta_i}\frac{\partial P_{nm}(\cos\theta_i)}{\partial\theta}\sin m\,\lambda_i + m\, M_{\lambda_i}\, P_{nm}(\cos\theta_i)\frac{\cos m\lambda_i}{\sin\theta_i}\right] .$$

These coefficients are calculated up to a user specified order. The power spectral content of the expansion is also computed as a function of order by the relation

$$S_n = \left[g_{no}^2+\sum_{m=1}^{n}(g_{nm}^2+h_{nm}^2)\right]^{\frac{1}{2}} .$$

(3) The set of estimated parameters has been extended to include the external field parameters $\bar{g}_{10}$, $\bar{g}_{11}$, $\bar{h}_{11}$ (on user option) in addition to the dipole parameters).

(4) A plot capability has been added to the software to plot the global locations of the dipoles and the values of the source magnetization.

(5) A separate software package has been developed (DIF) which computes the differences in D , H , Z and B on a global grid between a spherical harmonic and dipole model as a function of altitude. The differences are plotted as contours on world maps.

(6) A procedure for obtaining a more uniform distribution of dipoles on the surface of a sphere was implemented into subroutine EQUARE. The icosahedron regular polyhedron, with 20 equilateral triangular faces, can be inscribed in a sphere, and the edges radially projected onto the sphere forming "spherical polyhedrons". The spherical icosahedron is the division of the sphere having the greatest number of regular pieces, and forms the base on which a nearly uniform distribution of points on the sphere may be defined. The following sets of points has been implemented:

	# of Points	Angular Separation (Deg.)
1.	12	64°
2.	42	32°
3.	92	21°
4.	162	16°